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AUTHOR	Burgwardt, Frederick C.
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ABSTRACT

A number of factors are having an impact on the relationship between academic institutions and the industrial user. These are manifested in a search for new ways in which cooperation in the development and implementation of continuing engineering education programs for the practicing engineer can be improved. This paper presents two examples of what one industry and one academic institution have done on a cooperative basis to develop and execute new approaches to individualized instruction for the practicing engineer. Despite an active-on-site Master of Engineering Program at Colorado State University, there remained a need to revitalize the skills of senior engineering personnel in subject areas particularly unique to Xerox. The Professional Excellence Program (PEP) was developed to meet this need. The format, student selection procedures, development implementation and evaluation of the program are discussed. The background, development and production of a programmed instruction text in Electrostatics is discussed. The text was a cooperative venture with a faculty member providing the draft and hand-drawn illustrations and Xerox performing the final illustrating work and typesetting. (LS)

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(Title)

MAKING INDIVIDUALIZED INSTRUCTION A JOINT ACADEMIC/INDUSTRIAL VENTURE

Frederick C. Burgwardt
Manager, ITG/Education & Training Staff
Xerox Corporation
Joseph C. Wilson Center for Technology
Rochester, New York 14644

MAKING INDIVIDUALIZED INSTRUCTION A JOINT ACADEMIC/INDUSTRIAL VENTURE

By

Frederick C. Burgwardt

Introduction

A number of factors--current economic conditions, the need to more effectively market continuing education services, increasing awareness on the part of engineers to maintain their technical vitality through continuing engineering study, and more formalized industrial assessment on the value of employee development--are all having an impact on the relationship between academic institutions and the industrial user. It is manifested in a search for new ways in which cooperation in the development and implementation of continuing engineering education programs for the practicing engineer can be improved, and reflects the concern that formal continuing engineering education contribute to individual engineer performance and organizational productivity.

In response to these pressures there is an emerging trend toward individualized engineering education. Increasing numbers of pioneering efforts are being undertaken in an attempt to design educational experiences for the practicing engineer which are relevant and contribute more immediately to his job assignment.

This paper will present two examples of what one industry and one academic institution have done on a cooperative basis to develop and execute new approaches to individualized instruction for the practicing engineer.

Deterrents to CES

As professionals, the engineers' work environment is not totally unique, however; real or perceived factors are encountered which limit commitment or inhibit participation in many traditional academic continuing education programs. While many of these have long been identified and a variety of approaches have been used in an attempt to cope with them, until recently, little has been done by industry or academia to analyze the engineering career process. More formal exploration is beginning to take place, but a great deal remains to be lerned about the engineer and his relationship to continuing education needs. A review of potential constraints, therefore, might prove useful:

- One of the major factors affecting a typical engineer is that of time. Most engineers are concerned with how their

working hours are spent. Work assignment pressures are often intense and rigid, frequent meetings and presentations, unpredictable overtime schedules and detailed reports hinder, if not totally prevent, many engineers from attending regularly scheduled graduate courses. The more senior engineer has commitments to family, community, church and professional organizations which often take precedence over time available for a regimented and structured format of continuing education.

- A second concern is the *failure syndrom*. The average engineer, out of school five to ten or fifteen years, is well aware of the pressures of traditional graduate or advanced degree programs; and is concerned with the associated potential for failure and its implications on his career.. Often it has been some time since he has exercised his academic *muscles* and maintained disciplined study patterns. Intellectual skills are often *rusty* and his self-confidence to compete in a competitive advanced degree program with junior engineers may be less than optimal.

- Not surprising are survey findings that many senior engineers do not find graduate course content relevant to work assignments. Although they are *aware* of technological advances and the associated new devices and techniques, senior engineers question whether these skills can be acquired by completion of graduate level courses. In short, they perceive little payoff in improved job performance.

- It is reported that significant numbers of engineers feel they are under utilized. And indeed, much *engineering* work does involve *pencil pushing* and considerable time is spent driving through a volummous array of engineering standards and administrative procedures. Quite logically they may challenge the need for new and broadened job skills, when many of those they already possess are not being applied.

- More subtle factors are advancement and the reward system for engineering work. Often these lack visibility or are inadequately designed and administered. As a result, there is little to motivate engineers to pursue some form of self-development. The effectiveness of *dual ladder programs* may be challenged. With few exceptions, there is evidence that the *individual contributor* shares few of the financial and status rewards as his managerial *counterpart*.

Until recently, few *experts* have explored the peripheral motivational aspects of continuing education, and little was done through active coaching and counseling, or career planning to assist the engineer in self-development. Preliminary findings now suggest that one effective approach is to identify and respond to the needs of the *individual* through programs of individualized engineering education. As a result, industries and academic institutions are developing and testing new and innovative techniques of continuing education. Certainly, greater

attention is being focused on the need to better understand the engineers' role in industry and approaches which effectively address his/her developmental needs.

The success of these programs has, to a large extent, been based upon the establishment of a systematic communication technique and a willingness on the part of college faculty to understand the business, and the day-to-day activities of the engineer in his work assignment.

Professional Excellence Program (PEP)

NEED

Despite an active on-site Master of Engineering Program (enrollment had increased 400% over a two year period) there remained an identifiable need to revitalize the skills of more senior engineering personnel in subject areas particularly unique to Xerox. Although a wide range of undergraduate courses had been available at local institutions, a tuition aid study revealed participation was predominantly technicians working toward a baccalaureate degree. While it was not considered necessary that all engineering personnel obtain a graduate level degree, the introduction of new technologies, growing product complexity and the need to apply more analytical design techniques had evolved to the point where the understanding and having the ability of current undergraduate engineering skills was essential to adequate job performance. Despite new college graduate hiring, the number of senior engineers who had received their baccalaureate degrees within the last five to ten years had grown significantly. The major challenge was how to motivate this segment of the engineering population and more specifically to develop program format/content which would attract those who had not previously participated in formal continuing engineering courses.

PLANNING

A number of alternatives were developed, and discussed with senior management. As a result of these meetings, the following guidelines were established:

- <u>Format</u>: The PEP was initially planned as a concentrated non-credit program with an instruction schedule of one half-day per week over a ten week period. This decision was based on the judgement that any undergraduate course could best run concurrent to the Rochester Institute of Technology quarter system and thus facilitate planning of faculty on-campus teaching loads. It was further recommended that classes be conducted on-site in Webster during normal working hours.

  To insure instructional integrity, the program would include significant homework, class examples, and testing, although no final course grades were to be awarded. Lastly, it was proposed that the class size be limited to approximately 30 students to assure a reasonable degree of interaction between student and

instructor.

- Selection/Screening Criteria: It was recommended that participation in the PEP program be initiated in two ways: (1) employees could identify courses they felt necessary for immediate job assignments or career growth, and request participation through their immediate supervisor or (2) with Section Manager approval, specific employees could be asked to participate by their immediate supervisor. Indeed, selection might be a logical follow-on to a performance review or career/coaching session. All nominations, however, would be reviewed by the Training Department, and acceptance into the program would be based upon an assessment of course relevancy to specific job activity, assignment, or career plan.

DEVELOPMENT

The identification of pilot courses began with an examination of junior and senior electrical and mechanical engineering curriculums. Concurrently, engineering profiles of number, job assignment and years since last degree were studied. Discussions were conducted with engineering managers/practitioners to reduce the general list to specific subject areas. These were used as a basis for exploratory discussions.

Meetings were held with the Dean of the College of Engineering at Rochester Institute of Technology; and six potential courses were considered (three each from the electrical and mechanical engineering curriculums). The selection of faculty was felt to be critical and the choice of instructors greatly influenced initial course considerations. Programs in Heat Transfer and Materials Science areas were selected. Additional courses and the future of the program would be based upon the results of these *pilot* courses.

Concurrent with on-campus planning, two Xerox subject matter experts (SME's) were identified using both peer group and management recommendations. These SME's were designated Program Monitors. Their role would be to work with R.I.T. College of Engineering faculty in specifying course content and developing examples to assure course relevancy.

Two major efforts during course development would be the deletion of extraneous and non-relevant material, and the emphasis of areas where specific work examples and problem section would prove most profitable.

The initial faculty/SME meeting served primarily as an orientation. The faculty member had an opportunity to visit the SME in his work setting and learn about the product development activities in which engineers were involved. Several of these areas involved proprietary activities; faculty members therefore were asked to sign non-disclosure agreements.

Approximately two months later mutual agreement on course content was reached and the development of specific work and class examples was completed. It is interesting that SME's who held advanced engineering degrees

had a tendency to orient content more toward the graduate level. Constant effort was required to assure that the content remained at an undergraduate level consistent with program objectives. While the Heat Transfer course was to be instructed by one faculty member, it became evident that the course in Materials Science could best be *team* taught by two faculty members.

IMPLEMENTATION

With the development of instructional materials complete, the course was formally announced by distribution to Division management. The response was quite varied. In several instances training personnel were asked to participate in management staff meetings and review/explain program objectives, course content and selection criteria. In other instances memos were used to communicate course availability. Initial enrollment patterns were directly proportional to the interest and commitment exhibited by respective engineering managers in announcing the program. The initial response for each program, however, exceeded the planned enrollment of 30 students. As initially planned, the Training staff made final decisions for student acceptance based upon the established selection criteria.

Both pilot courses ran longer than the planned ten week period. This may be attributed to the intense interaction which developed during class periods. By mutual agreement the course was extended in order to cover the planned subject matter.

EVALUATION

A rigorous but separate postmortem was held with faculty members and students to assess the value, level and effectiveness of the course. There was good correlation between student and faculty observations on those areas which should be modified or strengthened before the course was offered again. In general, the reaction of the students was extremely favorable; faculty reported that homework assignments were faithfully completed and confessed they often found it necessary to research material between class periods in order to effectively pursue some of the job related *side roads*.

Despite job pressures, special meetings and out of town assignments, attrition was low, and most all of those who began these *pilot* courses completed them. Although no CEU's were awarded, a number of employees did apply participation in these programs toward recertification.

The summary report made to management resulted in the decision to continue and expand the program to other subject areas.

With the PEP program now completing its second year of operation, four new courses are being planned for 1975-76.

A particularly interesting side benefit, is that five faculty who conducted courses have now engaged in some form of consulting activity

within the Research and Engineering Division. Moreover, most have conducted reruns of the courses which they developed.

It is planned to expand the inventory of PEP courses as a means of strengthening the technical capabilities of one segment of the senior engineering workforce.

Electrostatic Field Theory - A Programmed Instruction Text

Another and perhaps more unique cooperative venture was the joint development of a programmed instruction text in Electrostatics.

BACKGROUND

A fundamental understanding of electrostatic field theory is essential for most everyone involved in the design and development of products using the xerographic process. In most AAS level programs, however, electrostatics does not receive a great deal of attention, and in many non-electrical baccalaureate engineering curriculums electrostatic field theory is taught at either the freshmen or sophomore level so retention is quite low. Since the training need was viewed as *long term*--required by many new employees--it seemed desirable to *package* the course for repeatability and availability at random times.

The development of a programmed instruction text was selected from a number of alternatives. To minimize development time the initial development concept involved identifying a SME to work with the Training staff and Materials Development group (program writer, technical illustrator and editor) during course development. Unfortunately, those SME's which were approached were too involved in current job responsibilities to participate.

A review of alternative resources led to the Electrical Engineering Department at R.I.T. and a faculty member who taught electrostatic field theory. Fortunately, this individual had been involved in developing technically oriented computer aided instruction materials for the R.I.T. National Technical Institute for the Deaf. This experience had encouraged him to develop an understanding of instructional materials development, and programming techniques.

The possibility of a cooperative development effort was discussed. The faculty member would provide a draft of text material with hand drawn illustrations, final illustrating work and typesetting would be performed by Xerox. Camera ready artwork would be returned to the faculty member for proof reading and validation prior to final printing. The project was deemed feasible and a Statement of Work was prepared and executed by the Xerox contracts office.

DEVELOPMENT

As a first step, the typical learner and associated entry level knowledge was defined. It was agreed that most would have a knowledge of algebra, some calculus and an understanding of math and physics at the AAS level.

Since the course was to be oriented to Xerox needs, certain aspects of the electrostatics theory would receive emphasis; examples related to the xerographic process would be developed for integration with theoretical material.

Interviews between the faculty and Xerox subject matter experts were conducted; from these, program objectives were developed. Working from a traditional course outline, course content was modified and specific examples developed to relate the theory to the xerographic process. Company books and materials served as reference materials for the faculty member during course development.

No specific length was assigned for the course; rather objectives would be met, regardless of course length. From the on-set program validation by both academic and industrial students with the prescribed entry level skills was planned. Instructional criteria stipulated a high degree of student participation. Further it was specified that the program would be modularized into time frames less than one hour in length. It was felt that longer time segments would degrade student motivation. Individual modules would be critiqued by subject matter experts upon completion and returned to the author only if revisions were required.

PRODUCTION

As text preparation progressed, draft manuscripts were hand lettered, and drawings were done free hand. Following SME review and approval, these were sent to the Materials Development Section for professional artwork preparation and typesetting. The only major production problem was the unfamiliarity of typesetting personnel with the technical subject matter and related symbols. As a result, xerographic copies of camera ready art were proofed by the faculty member and modifications involving missing or misplaced symbols were made. These were used for validation purposes.

Ten students were selected for validation; responses were evaluated by the faculty member and program modifications were made in areas where student responses indicated lack of clarity and/or sequencing problems.

STATUS

The final manuscript is presently at the printers and copies will be available on a volume basis within the next few weeks. The result of this project has been the development of an instructional instrument dealing with a unique Xerox technology in such a way as to be meaningful and relevant to our employees.

Overall Summary

The two experiences discussed may not be totally unique sofaras interaction between college and industry is concerned. The learning process we have

shared however, suggests that the success of these efforts is heavily dependent upon the degree of interaction between college and industry. While development of continuing education programs in a *cooperative venture* can have significant payoff for both the college and the user, there are more global implications that faculty members may find it necessary to broaden or acquire new skills to support new types of instructional material development.

Perhaps the common theme to both of these development stories is that materials were not developed in a vacuum, but evolved as a result of cooperative interaction between industry, subject matter expert, and the educational expertise of an academic institution. Undoubtedly we have learned that a relationship of trust and openness, and a sincere desire to establish meaningful dialogue must be developed for those institutions who wish to maintain or strengthen their role in continuing engineering education.

There are peripheral benefits, faculty consulting activities, an opportunity for faculty to learn how engineers apply their course work in local industry, and more importantly an opportunity to transfer new technologies to the undergraduate curriculum.

As this type of cooperative *venture* grows, the planning and implementation of on-going continuing engineering education programs will become more successful and improve the acceptance and commitment of industrial management.